What is claimed is:

1. An optical logic device for processing information optically using the transmitted and/or reflected characteristics of at least one stable, non-absorbing optical hard limiter.

2. The optical logic device of claim 1, wherein the at least one stable, non-absorbing optical hard limiter comprises alternating layers of materials with different linear indices and oppositely signed Kerr coefficients.

3. The optical logic device of claim 1, wherein the transmitted characteristics of a stable, non-absorbing optical hard limiter comprise:

a first range bounded by input signals in the range of approximately zero to I1 in which the transmitted output signal of the stable, non-absorbing optical hard limiter is approximately zero;

a second range bounded by input signals in the range approximately from I1 to I2 in which the transmitted output signal of the stable, non-absorbing optical hard limiter increases from zero to I2; and

a third range bounded by input signals in the range above approximately I2 in which the transmitted output signal of the stable, non-absorbing optical hard limiter is approximately I2, where I1 is approximately half of I2.

4. The optical logic device of claim 1, wherein the reflected characteristics of a stable, non-absorbing optical hard limiter comprise:

a first range bounded by input signals in the range of approximately zero to I1 in which the reflected output signal of the stable, non-absorbing optical hard limiter approximately equal to the input signal;

a second range bounded by input signals in the range approximately from I1 to I2 in which the reflected output signal of the stable, non-absorbing optical hard limiter decreases from approximately I1 for an input signal of I1 to approximately zero for an input signal of I2; and

a third range bounded by input signals in the range above approximately I2 in which the reflected output signal of the stable, non-absorbing optical hard limiter is increases as the input signal increases above I2, where I1 is approximately half of I2.

5. An optical gain element for converting an optical input signal having an intensity substantially from the set {0, I1} to an optical output signal having an intensity substantially from the set {0, I2}, where I1 is approximately half of I2, the all-optical gain element comprising:

a first stable, non-absorbing optical hard limiter operably coupled to receive as its input a combination of the optical input signal and a signal having an intensity of approximately 4 I1 combined in an approximately 80:20 ratio;

a second stable, non-absorbing optical hard limiter operably coupled to receive as its input a combination of the transmitted output signal from the first stable, non-absorbing optical hard limited and a signal having an intensity of approximately 5 I1 combined in an approximately 80:20 ratio; and

a third stable, non-absorbing optical hard limiter operably coupled to receive as its input a combination of the transmitted output signal from the second stable, non-absorbing optical hard limited and a signal having an intensity of approximately 4.88 I1 combined in an approximately 80:20 ratio and to output its transmitted signal as the output of the optical gain element.

6. An optical AND gate comprising a stable, non-absorbing optical hard limiter operably coupled to receive as its input a combination of a first input signal and a second input signal combined in an approximately 50:50 ratio and to output its transmitted signal as the output of the optical AND gate, wherein:

the combined input signal is approximately zero and the output of the optical AND gate is approximately zero when both the first input signal and the second input signal are zero;

the combined input signal is approximately I1 and the output of the optical AND gate is approximately zero when the first input signal is zero and the second input signal is I2;

the combined input signal is approximately I1 and the output of the optical AND gate is approximately zero when the first input signal is I2 and the second input signal is zero;

the combined input signal is approximately I2 and the output of the optical AND gate is approximately I2 when the first input signal is I2 and the second input signal is I2; and

I1 is approximately half of I2.

7. An optical OR gate comprising an optical gain element for converting an optical input signal having an intensity substantially from the set {0, I1} to an optical output signal having an intensity substantially from the set {0, I2, wherein the optical gain element is operably coupled to receive as its input a combination of a first input signal and a second input signal combined in an approximately 50:50 ratio and to output the converted signal as the output of the optical OR gate, and wherein:

the combined input signal is approximately zero and the output of the optical OR gate is approximately zero when both the first input signal and the second input signal are zero;

the combined input signal is approximately I1 and the output of the optical OR gate is approximately I2 when the first input signal is zero and the second input signal is I2;

the combined input signal is approximately I1 and the output of the optical OR gate is approximately I2 when the first input signal is I2 and the second input signal is zero;

the combined input signal is approximately I2 and the output of the optical OR gate is approximately I2 when the first input signal is I2 and the second input signal is I2; and

I1 is approximately half of I2.

8. An optical XOR gate comprising:

a stable, non-absorbing optical hard limiter operably coupled to receive as its input a combination of a first input signal and a second input signal combined in an approximately 50:50 ratio; and

an optical gain element for converting an optical input signal having an intensity substantially from the set {0, I1} to an optical output signal having an intensity substantially from the set {0, I2}, the optical gain element operably coupled to receive as its input a reflected signal from the stable, non-absorbing optical hard limiter and to output the converted signal as the output of the optical XOR gate, wherein:

the combined input signal is approximately zero, the reflected signal is approximately zero, and the output of the optical XOR gate is approximately zero when both the first input signal and the second input signal are zero;

the combined input signal is approximately I1, the reflected signal is approximately I1, and the output of the optical XOR gate is approximately I2 when the first input signal is zero and the second input signal is I2;

the combined input signal is approximately I1, the reflected signal is approximately I1, and the output of the optical XOR gate is approximately I2 when the first input signal is I2 and the second input signal is zero;

the combined input signal is approximately I2, the reflected signal is approximately zero, and the output of the optical XOR gate is approximately zero when the first input signal is I2 and the second input signal is I2; and

I1 is approximately half of I2.

9. An optical NOT gate comprising:

a stable, non-absorbing optical hard limiter operably coupled to receive as its input a combination of an input signal and a fixed signal of approximate intensity I2 combined in an approximately 50:50 ratio; and

an optical gain element for converting an optical input signal having an intensity substantially from the set {0, I1} to an optical output signal having an intensity substantially from the set {0, I2}, the optical gain element operably coupled to receive as its input a reflected signal from the stable, non-

absorbing optical hard limiter and to output the converted signal as the output of the optical NOT gate, wherein:

the combined input signal is approximately I1, the reflected signal is approximately I1, and the output of the optical NOT gate is approximately I2 when the input signal is zero;

the combined input signal is approximately I2, the reflected signal is approximately zero, and the output of the optical NOT gate is approximately zero when the input signal is I2; and

I1 is approximately half of I2.

10. An optical NAND gate comprising:

an optical AND gate; and

an optical NOT gate operably coupled to an output of the optical AND gate for logically inverting the output of the optical AND gate, wherein the optical AND gate and the optical NOT gate are based on stable, non-absorbing optical hard limiters.

11. An optical NOR gate comprising:

an optical OR gate; and

an optical NOT gate operably coupled to an output of the optical OR gate for logically inverting the output of the optical OR gate, wherein the optical OR gate and the optical NOT gate are based on stable, non-absorbing optical hard limiters.